October 11, 2005

VIA HAND DELIVERY

Ms. Mary L. Cottrell, Secretary
Department of Telecommunications and Energy
One South Station, 2nd floor
Boston, MA 02110

> Re: Investigation by the Department Regarding Service
> Quality Guidelines Established in Service Quality
> Standards for Electric Distribution Companies and Local
> Gas Distribution Companies, D.T.E. 04-116

Dear Secretary Cottrell:

Enclosed for filing on behalf of Fitchburg Gas and Electric Light Company d/b/a Unitil ("Unitil"), please find an original and one (1) copy of Unitil's responses to the Department's sixth set of information requests to all Electric Local Distribution Companies in the above-referenced docket. As requested, copies of Unitil's responses are being sent by e-mail to the parties.

Thank you for your attention to this matter.

Sincerely,

Gary Epler

Enclosure

cc: Jody M. Stiefel, Hearing Officer

Gary Epler
Senior Attorney

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Commonwealth of Massachusetts
Department of Telecommunications and Energy
Fitchburg Gas and Electric Light Company d/b/a Unitil
Docket No: D.T.E. 04-116
Department's Sixth Set of Document and Information Requests

Request No. DTE-LDC 6-1

As an alternative to mandatory inspection and maintenance guidelines, please identify new Service Quality performance measures to realize the effective maintenance of your system?

Response:

Unitil believes that the results of inspection and maintenance policies and procedures are measurable in existing Service Quality guidelines. Proper inspection and maintenance policies and procedures result in reliable service to customers. The current Service Quality guidelines require reporting of reliability data by each electric and gas distribution company.

In addition to reliability measurements, customer satisfaction measurements reflect the quality of gas and distribution systems as perceived by the customers of each utility company.

Unitil does not believe that further Service Quality measures need to be instituted to realize the effective maintenance of electric and gas distribution systems.

Person Responsible: Christopher Dube & Christopher Leblanc
Date: October 11, 2005

Commonwealth of Massachusetts
Department of Telecommunications and Energy
Fitchburg Gas and Electric Light Company d/b/a Unitil
Docket No: D.T.E. 04-116
Department's Sixth Set of Document and Information Requests

Request No. DTE-LDC 6-2

Using the Company's available historical outage information, please provide, in an active excel spreadsheet, a calculated required minimum number of customers affected to qualify for exclusion under IEEE-1366, med and the associated values of " (Alpha), $ (Beta), T , SAIDI, and total customer minute interruption for the years 2000, 2001, 2002, 2003, and 2004, for each of the following assumed interruption durations: 1minute, 5 minutes, 60 minutes, 360 minutes, 720 minutes, 1,440 minutes and 2,880 minutes.

Response:

See Attachment DTE LDC 6-2.

Person Responsible: Kevin Sprague   **Date:** October 11, 2005

Commonwealth of Massachusetts
Department of Telecommunications and Energy
Fitchburg Gas and Electric Light Company d/b/a Unitil
Docket No: D.T.E. 04-116
Department Staff's First Set of Document and Information Requests
Attachment DTE LDC 6-2

Year	2000	2001	2002	2003	2004
Average # of Customers Served	26,138	26,138	26,295	26,189	26,569
Alpha	-2.15	-2.23	-2.37	-2.35	-2.36
Beta	2.25	2.26	2.24	2.27	2.29
Tmed	32.33	30.76	25.21	27.59	28.82
Customer Hours for MEDs	83347.90	0.00	12702.72	23447.97	20817.98
SAIDI (IEEE 1366 exclusions)	134.12	155.67	210.56	153.06	190.82
Total Customer Hours of Interruption (IEEE 1366 Exclusions)	58,425.10	67,813.00	92,277.70	66,806.62	84,500.08
Min # Customers Affected for MED Exclusion					
1	845,139	804,130	662,978	722,532	765,637
5	169,028	160,826	132,596	144,506	153,127
60	14,086	13,402	11,050	12,042	12,761
360	2,348	2,234	1,842	2,007	2,127
720	1,174	1,117	921	1,004	1,063
1440	587	558	460	502	532
2880	293	279	230	251	266

Commonwealth of Massachusetts
Department of Telecommunications and Energy
Fitchburg Gas and Electric Light Company d/b/a Unitil
Docket No: D.T.E. 04-116
Department's Sixth Set of Document and Information Requests

Request No. DTE-LDC 6-3

Regarding line loss, each electric company indicated that line loss was equal to the difference between energy requirement and energy sold, and that the loss includes various components such as actual system loss, theft, etc. Please list all the various components that your Company includes in reporting line loss, and briefly describe why each component is included in the line loss.

Response:

Included as part of Unitil's electric line loss figure are Company use, system losses, and voltage discounts made to certain general service accounts' metered data in accordance with the Company's tariff.

Company use is included in the line loss because Unitil does not record its Fitchburg facility's sales in its energy sold amount. Company usage also includes items such as substation equipment and line equipment.

Unitil does not have metering in place that measures system losses. System losses include transformer load and no load losses, conductor losses, meter losses, and theft.

Voltage discounts are included in the electric line loss figure. This accounts for transformer losses associated with customer owned equipment.

Person Responsible: Kevin Sprague   **Date:** October 11, 2005

Commonwealth of Massachusetts
Department of Telecommunications and Energy
Fitchburg Gas and Electric Light Company d/b/a Unitil
Docket No: D.T.E. 04-116
Department's Sixth Set of Document and Information Requests

Request No. DTE-LDC 6-4

Regarding line loss, please describe:

(a) how the distribution and transmission loss factors that are reported to ISO-NE for the load settlement process are determined, include all supporting documents and a copy of the most recently reported loss factors for each voltage level;

(b) how often the distribution and transmission loss factors reported to ISO-NE are updated;

(c) what steps the Company currently takes to reduce its loss factors, and what steps the Company plans to take in the future to reduce its loss factors;

(d) how the Company benefits, if at all, from reducing its loss factors;

(e) what steps the Department could take to reduce loss factors;

(f) for what purposes, other than load settlement, the Company uses its loss factors, describe each purpose and provide any supporting documents.

Response:

(a) Loss factors that are included in the hourly loads reported to ISO-NE for the load settlement process are determined by conducting a system loss study. A copy of Unitil's last loss study from D.P.U. 90-122 is attached as Attachment DTE-LDC 6-4 (a).

(b) Loss factors that are included in the hourly loads reported to ISO-NE for the load settlement process would normally be updated in a general rate case, or more frequent, if warranted. However, the last time Unitil conducted a loss study was in 1989 for docket D.P.U. 90-122.

(c) Unitil takes several steps to manage system losses. These steps include evaluating losses on power transformers, service transformer specifications, and reactive VAR support.

When Unitil purchases power transformers that are used in substation applications, part of the specification details the loss factors used in the

Commonwealth of Massachusetts
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evaluation of the transformer. These loss factors are updated as needed and used to evaluate the total owning cost of various transformer quotes prior to accepting one of the bids.

For distribution service transformers, Unitil has adopted the *NEMA TP 1 Guide for Determining Energy Efficiency for Distribution Transformers* in all transformer specifications. Units that do not meet this efficiency standard will not be purchased.

Unitil evaluates changes in line loss as one of the factors in the economic analysis when evaluating multiple alternatives. Line loss is not generally the determining factor, though it may have an effect on the final decision. Unitil provides the Department with a copy of its Economic Evaluation Procedures as an attachment to the annual 01-67 filing. See Attachment 6 of Unitil's 01-67 Annual Report 2004, dated January 2005.

Losses through power transformers can be rather substantial during peak loading periods. Unitil actively manages the reactive requirements throughout the system in an attempt to reduce the losses through substation power transformers.

Unitil plans to continue these practices to actively manage system losses.

(d) It is Unitil's goal to operate and maintain an efficient distribution system. One aspect of an efficient distribution system is losses. Lower system losses results in a lower cost per kwh for all customers. Decreasing system losses, in specific areas, may also result in decreasing voltage drop.

(e) Unitil actively manages system losses during the planning processes. It is not apparent to Unitil how the Department could reduce loss factors.

(f) In addition to the response in part (c) of this response, loss factors are used to adjust billing determinants in a rate case to get loss adjusted figures. Also, distribution losses are considered in the computation of class average load profiles to adjust meter point data to system level data.

Person Responsible: Kevin Sprague   **Date:** October 11, 2005

Attachment DTE-LDC 6-4(a)

EXHIBIT IX

LOSS STUDY

Loss Calculations

The loss factors used in this study are summarized on the following pages. There are two portions of this study, the embedded losses and the marginal losses. The first three pages summarize the class loss factors by three time periods, on peak hours, off peak hours and all hours. On these pages, the MWh sales are the booked sales, the MWh loss is taken from schedule 1a, and the reallocation of transformer losses takes into account the 3% loss associated with transformer loss on customer premises. The loss factors are calculated for the following customer classes and their associated voltage levels and are summarized as follows:

Class	On Peak Loss	Off Peak Loss	Average Loss
R1/R4	9.23%	6.01%	7.52%
R2	9.23%	6.01%	7.52%
G1	9.23%	6.01%	7.89%
G2/G4/G5	9.09%	5.77%	7.72%
G3	5.40%	3.40%	4.45%
OL	9.23%	6.01%	6.71%

These loss factors are applied to the sales to produce the loss adjusted kWh sales for each class.

The accompanying schedules and workpapers are numbered as follows and are included in both the embedded and marginal sections of the study:

Schedule 1A	Summary of MWH Losses
Schedule 1B	Summary of MW Losses on Peak
Schedule 2A	Average Annual Losses
Schedules 2B	Average On Peak and Off Peak Losses
Schedule 3	Peak Hour Losses
Workpaper 1	Load and Load Flow Data
Workpaper 2A	Substation Load Information
Workpaper 2B	Distribution Transformer Load Information
Workpaper 2C	Transformer Load and Line Loss Information

FITCHBURG GAS AND ELECTRIC LIGHT COMPANY
ALLOCATED ENERGY LOSS FACTORS
ALL HOURS TEST YEAR 1989

TOTAL MWH SALES   372,753.9 MWH

	TOTAL MWH SALES	MWH LOSS	REALLOCATION OF TRANSFORMER LOSS (1)	% OF LOSS TO SALES	CUMULATIVE % OF LOSS TO SALES
TRANSMISSION	372,754	1,155	1,155	0.31%	0.31%
SUB-TRANSMISSION	372,754	1,720	3,413	0.92%	1.23%
PRIMARY	316,338	14,524	15,949	5.04%	6.27%
SECONDARY	268,837	6,964	3,846	1.43%	7.70%
		24,363	24,363		

R1/R4/R2/G1/S1

RESIDENTIAL / STREET LIGHTING LOSS FACTOR: 7.70

WEIGHTED LOSS FACTORS BY CLASS TEST YEAR 89:

INDUSTRIAL / G-3

	ACTUAL MWH SALES	WT	CUM LOSS %	WTD LOSS
SUB-TRANS (2)	56,416	44.37%	1.23%	0.54%
PRIMARY (3)	33,554	26.39%	6.27%	1.65%
SECONDARY	37,178	29.24%	7.70%	2.25%
TOTAL	127,148	100%		4.45%

63

4.45

COMMERCIAL / G-2

	ACTUAL MWH SALES	WT	CUM LOSS %	WTD LOSS
PRIMARY (3)	13,947	12.997%	6.27%	0.81%
SECONDARY	93,365	87.003%	7.70%	6.70%
TOTAL	107,313	100%		7.51%

G2

7.51:

	TOTAL	R-1, R-4	R-2	G-1	G-2	G-3	S-1
KWH SALES	372,753,900	123,702,301	7,807,614	3,729,277	107,312,543	127,148,252	3,053,913
% LOSS ADJUSTMENT		7.52%	7.52%	7.89%	7.72%	4.48%	6.71:
LOSS ADJUSTMENT	24,363,013	9,299,741	586,964	294,415	8,279,838	5,697,238	204,818
KWH SALES (LOSS ADJUSTED)	397,116,913	133,002,042	8,394,578	4,023,692	115,592,381	132,845,490	3,258,731

SUMPTIONS: (1) ADJUSTED BY 3% OF MWH SALES AT SUBTRANSMISSION(2) AND PRIMARY(3), TO REFLECT TRANSFORMER LOSSES ON CUSTOMER PREMISES.

NOTES: SUM OF ON/OFF PEAK ADJUSTED FOR CLASS ON/OFF PEAK DIVERSITY
              MWH LOSS DATA AT AVERAGE LOAD LEVEL FROM LOSS STUDY ADJUSTED FOR 1989 (SCHEDULE 1A, SECTION I).

FITCHBURG GAS AND ELECTRIC LIGHT COMPANY
ALLOCATED ENERGY LOSS FACTORS
ON-PEAK TEST YEAR 1989

TOTAL MWH SALES   195,166 MWH

	TOTAL MWH SALES	MWH LOSS	REALLOCATION OF TRANSFORMER LOSS (1)	% OF LOSS TO SALES	CUMULATIVE % OF LOSS TO SALES
TRANSMISSION	195,166	612	612	0.31%	0.31%
SUB-TRANSMISSION	195,166	863	1,778	0.91%	1.22%
PRIMARY	165,670	10,734	11,523	6.96%	8.17%
SECONDARY	139,358	3,172	1,468	1.05%	9.23%
		15,382	15,382		

R1/R4/R2/G1/S1

RESIDENTIAL / STREET LIGHTING LOSS FACTOR: 9.2

WEIGHTED LOSS FACTORS BY CLASS TEST YEAR 89:

INDUSTRIAL / G-3

	ACTUAL MWH SALES	WT	CUM LOSS %	WTD LOSS
SUB-TRANS (2)	30,495	44.37%	1.22%	0.54%
PRIMARY (3)	18,137	26.39%	8.17%	2.16%
SECONDARY	20,097	29.24%	9.23%	2.70%
TOTAL	68,729	100%		5.40%

63

5.40

COMMERCIAL / G-2

	ACTUAL MWH SALES	WT	CUM LOSS %	WTD LOSS
PRIMARY (3)	8,175	12.997%	8.17%	1.06%
SECONDARY	54,722	87.003%	9.23%	8.03%
TOTAL	62,896	100%		9.09%

62

9.09

	TOTAL	R-1,R-4	R-2	G-1	G-2	G-3	S-1
KWH SALES	195,165,700	58,028,423	3,662,531	2,185,738	62,896,144	68,729,369	663,495
% LOSS ADJUSTMENT		9.23%	9.23%	9.23%	9.09%	5.40%	9.23
LOSS ADJUSTMENT	15,382,074	5,354,729	337,970	201,695	5,717,785	3,708,670	61,226
KWH SALES (LOSS ADJUSTED)	211,547,774	63,383,152	4,000,501	2,387,433	68,613,929	72,438,039	724,721

ASSUMPTIONS: (1) ADJUSTED BY 3% OF MWH SALES AT SUBTRANSMISSION(2) AND PRIMARY(3), TO REFLECT TRANSFORMER LOSSES ON CUSTOMER PREMISES.

* MWH LOSS DATA AT ON-PEAK LOAD LEVEL FROM 1986 LOSS STUDY ADJUSTED FOR 1989 (SCHEDULE 1A, SECTION I).

FITCHBURG GAS AND ELECTRIC LIGHT COMPANY
ALLOCATED ENERGY LOSS FACTORS
OFF-PEAK TEST YEAR 1989

TOTAL MWH SALES   176,588 MWH

	TOTAL MWH SALES	MWH LOSS	REALLOCATION OF TRANSFORMER LOSS (1)	% OF LOSS TO SALES	CUMULATIVE % OF LOSS TO SALES
TRANSMISSION	176,588	542	542	0.31%	0.31%
SUB-TRANSMISSION	176,588	857	1,635	0.93%	1.23%
PRIMARY	150,668	3,790	4,426	2.94%	4.17%
SECONDARY	129,478	3,791	2,378	1.84%	6.01%
		8,981	8,981		

R1/R4/R2/G1/S1

RESIDENTIAL / STREET LIGHTING LOSS FACTOR: 6.0

WEIGHTED LOSS FACTORS BY CLASS TEST YEAR 89:

INDUSTRIAL / G-3

	ACTUAL MWH SALES	WT	CUM LOSS %	WTD LOSS
SUB-TRANS (2)	25,921	44.37%	1.23%	0.55%
PRIMARY (3)	15,417	26.39%	4.17%	1.10%
SECONDARY	17,082	29.24%	6.01%	1.76%
TOTAL	58,419	100%		3.40%

G3

3.4C

COMMERCIAL / G-2

	ACTUAL MWH SALES	WT	CUM LOSS %	WTD LOSS
PRIMARY (3)	5,773	12.997%	4.17%	0.54%
SECONDARY	38,644	87.003%	6.01%	5.23%
TOTAL	44,416	100%		5.77%

G2

5.77

	TOTAL	R-1, R-4	R-2	G-1	G-2	G-3	S-1
KWH SALES	176,588,200	65,673,878	4,145,083	1,543,539	44,416,399	58,418,883	2,390,418
% LOSS ADJUSTMENT		6.01%	6.01%	6.01%	5.77%	3.40%	6.01%
LOSS ADJUSTMENT	8,980,939	3,945,012	248,994	92,720	2,562,053	1,988,569	143,592
KWH SALES (LOSS ADJUSTED)	185,569,139	69,618,890	4,394,077	1,636,259	46,978,452	60,407,452	2,534,010

ASSUMPTIONS: (1) ADJUSTED BY 3% OF MWH SALES AT SUBTRANSMISSION(2) AND PRIMARY(3), TO REFLECT TRANSFORMER LOSSES ON CUSTOMER PREMISES.

* MWH LOSS DATA AT OFF-PEAK LOAD LEVEL FROM 1986 LOSS STUDY ADJUSTED FOR 1989 (SCHEDULE 1A, SECTION I).

Embedded Loss Study

I. AVERAGE LOAD LEVEL (47.76 MW)

	LINE	CORE	COIL	TOTAL MWH	CUMULATIVE MWH
TRANSMISSION	1,155	—	—	1,155	1,155
SUBTRANSMISSION	324	894	502	1,720	2,875
PRIMARY	12,459	1,288	778	14,524	17,399
SECONDARY	256	5,935	773	6,964	24,363

II. ON PEAK LOAD LEVEL (72.7 MW)

	LINE	CORE	COIL	TOTAL MWH	CUMULATIVE MWH
TRANSMISSION	612	—	—	612	612
SUBTRANSMISSION	172	383	309	863	1,476
PRIMARY	9,705	551	478	10,734	12,210
SECONDARY	157	2,541	475	3,172	15,382

III. OFF PEAK LOAD LEVEL (48.25 MW)

	LINE	CORE	COIL	TOTAL MWH	CUMULATIVE MWH
TRANSMISSION	542	—	—	542	542
SUBTRANSMISSION	152	511	194	857	1,399
PRIMARY	2,754	736	300	3,790	5,190
SECONDARY	99	3,395	298	3,791	8,981

I. AT PEAK LOAD LEVEL (72.7 MW)

	LINE	CORE	COIL	TOTAL MW	CUMULATIVE MW
TRANSMISSION	0.2960	----	----	0.2960	0.2960
SUBTRANSMISSION	0.1003	0.1020	0.1329	0.3352	0.6311
PRIMARY	7.0378	0.1470	0.2058	7.3906	8.0217
SECONDARY	0.0734	0.6776	0.2044	0.9554	8.9771

HOURS IN
PERIOD   8760

I. TRANSMISSION

A. LINE LOSSES = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
= (89 PEAK/ 81 OFF PEAK * ANNUAL LOAD FACTOR)^2 * OFF PEAK LINE LOSSES * HOURS PER PERIOD
= 1.0008 * 0.1317 * 8760
= 0.1318 * 8760
= 1,155 MWH
==========

B. TRANSFORMER LOSSES

CORE   =   NONE

COIL   =   NONE

II. SUBTRANSMISSION

A. LINE LOSSES = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
= (89 PEAK/ 81 OFF PEAK * ANNUAL LOAD FACTOR)^2 * OFF PEAK LINE LOSSES * HOURS PER PERIOD
= 1.0008 * 0.037 * 8760
= 0.0370 * 8760
= 324 MWH
==========

B. TRANSFORMER LOSSES

CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B) * HRS IN PERIOD
=   51.000 *   0.002 *   8760
=   0.1020 *   8760
=   894 MWH
==========

COIL   = (RATIO OF PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
= (33.613 /   51.000 *0.656928) ^2 *   51.000 *   0.006 *   8760
=   0.0574 *   8760
=   502 MWH
==========

III. PRIMARY

B. TRANSFORMER LOSSES

CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B) * HRS IN PERIOD
=   73.500 *   0.002 *   8760
=   0.1470 *   8760
=   1288 MWH
==========

COIL   = (RATIO OF PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
= (50.204 /   73.500 *0.656928) ^2 *   73.500 *   0.006 *   8760
=   0.0888 *   8760
=   778 MWH
==========

IV. SECONDARY

B. TRANSFORMER LOSSES

CORE   = CORE LOSS IN MW FROM WORKPAPER 2B * HOURS IN PERIOD
=   0.6776 *   8760
=   5935 MWH
==========

COIL   = (RATIO OF PRIMARY PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
= (50.204 / 148.917 *0.656928) ^2 *   148.917 *0.012079 *   8760
=   0.0882 *   8760
=   773 MWH
==========

V. DERIVATION OF PRIMARY AND SECONDARY LINE LOSSES

TOTAL ANNUAL LOSSES=   24363 MWH
TOTAL IDENTIFIED   =   11649 MWH

REMAINING LOSSES   =   12714 MWH

PRIMARY LINE LOSSES   = PRIMARY LOSS FACTOR FROM WORKPAPER 2C * REMAINING LOSSES
=   0.9799 *   12714
=   12459 MWH
==========

SECONDARY LINE LOSSES = SECONDARY LOSS FACTOR FROM WORKPAPER 2C * REMAINING LOSSES
=   0.0201 *   12714
=   256 MWH
==========

HOURS IN
PERIOD   3750

I. TRANSMISSION

    A. LINE LOSSES   = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
                       = (89 PEAK/ 81 PEAK * ON PEAK LOAD FACTOR)^2 * ON PEAK LINE LOSSES * HOURS PER PERIOD
                       =   0.7640 *   0.2565 *   3750
                       =   0.1960 *   3750
                       =   735 MWH
                                =========

    B. TRANSFORMER LOSSES
         CORE   =   NONE

         COIL   =   NONE

II. SUBTRANSMISSION

    A. LINE LOSSES   = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
                       = (89 PEAK/ 81 ON PEAK * ON PEAK LOAD FACTOR)^2 * ON PEAK LINE LOSSES * HOURS PER PERIOD
                       =   0.7640 *   0.0869 *   3750
                       =   0.0664 *   3750
                       =   249 MWH
                                =========

    B. TRANSFORMER LOSSES

         CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B) * HRS IN PERIOD
                   =   51.000 *   0.002 *   3750
                   =   0.1020 *   3750
                   =   383 MWH
                            =========

         COIL   = (RATIO OF PK TO NAMEPLATE*ON PK LOAD FCTR)^2 * NMPLATE RATE * WEST LOSS FCTR * HRS IN PERIOD
                   = (33.613 /   51.000 *0.813692) ^2 *   51.000 *   0.006 *   3750
                   =   0.0880 *   3750
                   =   330 MWH
                            =========

III. PRIMARY

    B. TRANSFORMER LOSSES

         CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B) * HRS IN PERIOD
                   =   73.500 *   0.002 *   3750
                   =   0.1470 *   3750
                   =   551 MWH
                            =========

         COIL   = (RATIO OF PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
                   = (50.204 /   73.500 *0.813692) ^2 *   73.500 *   0.006 *   3750
                   =   0.1362 *   3750
                   =   511 MWH
                            =========

IV. SECONDARY

    B. TRANSFORMER LOSSES

         CORE   = CORE LOSS IN MW FROM WORKPAPER 2B * HOURS IN PERIOD
                   =   0.6776 *   3750
                   =   2541 MWH
                            =========

         COIL   = (RATIO OF PRIMARY PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
                   = (50.204 / 148.917 *0.813692) ^2 *   148.917 *0.012079 *   3750
                   =   0.1354 *   3750
                   =   508 MWH
                            =========

V. DERIVATION OF PRIMARY AND SECONDARY LINE LOSSES

    PRIMARY LINE LOSSES   = ADJUSTED PRIMARY ON-PEAK LOSS FROM WORKPAPER 2C
         ON-PEAK   =   10658 MWH
                                    =========

    SECONDARY LINE LOSSES = ADJUSTED SECONDARY ON-PEAK LOSS FROM WORKPAPER 2C
         ON-PEAK   =   168 MWH
                                    =========

HOURS IN
PERIOD   5010

I. TRANSMISSION

A. LINE LOSSES

= PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
= (89 OFF-PEAK PEAK/ 81 OFF-PEAK PEAK * OFF PEAK LOAD FACTOR)^2 * OFF PEAK LINE LOSSES * HOURS PER PERIC
=   0.8217 *   0.1317 *   5010
=   0.1082 *   5010
=   542 MWH
==========

B. TRANSFORMER LOSSES

CORE   =   NONE

COIL   =   NONE

II. SUBTRANSMISSION

A. LINE LOSSES

= PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
= (89 OFF-PEAK PEAK/ 81 OFF-PEAK PEAK * OFF PEAK LOAD FACTOR)^2 * OFF PEAK LINE LOSSES * HOURS PER PERIO
=   0.8217 *   0.037 *   5010
=   0.0304 *   5010
=   152 MWH
==========

B. TRANSFORMER LOSSES

CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B) * HRS IN PERIOD
=   51.000 *   0.002 *   5010
=   0.1020 *   5010
=   511 MWH
==========

COIL   = (RATIO OF PK TO NAMEPLATE*OFF PK LOAD FCTR)^2 * NMPLATE RATE * WEST LOSS FCTR * HRS IN PERIOD
=   (33.613 / 51.000 * 0.5396) ^2 *   51.000 *   0.006 *   5010
=   0.0387 *   5010
=   194 MWH
==========

III. PRIMARY

B. TRANSFORMER LOSSES

CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B) * HRS IN PERIOD
=   73.500 *   0.002 *   5010
=   0.1470 *   5010
=   736 MWH
==========

COIL   = (RATIO OF PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
=   (50.204 / 73.500 * 0.5396) ^2 *   73.500 *   0.006 *   5010
=   0.0599 *   5010
=   300 MWH
==========

IV. SECONDARY

B. TRANSFORMER LOSSES

CORE   = CORE LOSS IN MW FROM WORKPAPER 2B * HOURS IN PERIOD
=   0.6776 *   5010
=   3395 MWH
==========

COIL   = (RATIO OF PRIMARY PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
=   (50.204 / 148.917 * 0.5396) ^2 *   148.917 *0.012079 *   5010
=   0.0595 *   5010
=   298 MWH
==========

V. DERIVATION OF PRIMARY AND SECONDARY LINE LOSSES

PRIMARY LINE LOSSES   = ADJUSTED PRIMARY OFF-PEAK LOSS FROM WORKPAPER 2C
OFF-PEAK   =   2754 MWH
==========

SECONDARY LINE LOSSES   = ADJUSTED SECONDARY OFF-PEAK LOSS FROM WORKPAPER 2C
OFF-PEAK   =   99 MWH
==========

I. TRANSMISSION

A. LINE LOSSES = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD

= (89 PEAK/ 81 PEAK)^2 * ON PEAK LINE LOSSES

=   1.1538 *   0.2565

=   0.2960 MW
==========

B. TRANSFORMER LOSSES

CORE   =   NONE

COIL   =   NONE

II. SUBTRANSMISSION

A. LINE LOSSES = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD

= (89 PEAK/ 81 PEAK)^2 * ON PEAK LINE LOSSES

=   1.1538 *   0.0869

=   0.1003 MW
==========

B. TRANSFORMER LOSSES

CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B)

=   51.000 *   0.002

=   0.1020 MW
==========

COIL   = (RATIO OF PK TO NAMEPLATE)^2 * NMPLATE RATE * WEST LOSS FCTR

=   (33.613 /   51.000) ^2 *   51.000   *   0.006

=   0.1329 MW
==========

III. PRIMARY

B. TRANSFORMER LOSSES

CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B)

=   73.500 *   0.002

=   0.1470 MW
==========

COIL   = (RATIO OF PEAK TO NAMEPLATE)^2 * NAMEPLATE RATING * LOSS FACTOR

=   (50.204 /   73.500) ^2 *   73.500   *   0.006

=   0.2058 MW
==========

IV. SECONDARY

B. TRANSFORMER LOSSES

CORE   = CORE LOSS IN MW FROM WORKPAPER 2B * HOURS IN PERIOD

=   0.6776 MW
==========

COIL   = (RATIO OF PRIMARY PEAK TO NAMEPLATE)^2 * NAMEPLATE RATING * LOSS FACTOR

=   (50.204 / 148.917) ^2 *   148.917   *   0.012079

=   0.2044 MW
==========

V. DERIVATION OF PRIMARY AND SECONDARY LINE LOSSES

PRIMARY LINE LOSS   = (AMPS * % LOAD ON PEAK)^2*MILES*CONDUCTORS*OHMS PER M FT*5.28 MFT PER MILE

ON-PEAK   =(230   *   0.40)^2 *   477.05   * 2 * 0.1635 *   5.28

=   7.038 MW
==========

SECONDARY SERVICES   = (AMPS)^2*OHMS PER MFT*CUSTOMERS*DROP FT*CONDUCTORS

ON-PEAK LOSSES   =(6) ^ 2 *   0.4157   80 *   24288   * 2

=   0.0582 MW
==========

SECONDARY MAINS   ASSUME 2 SPANS, 2 CUSTOMERS EACH WITH 75% COINCIDENCE FAC

ON-PEAK LOSSES   = (2*AMPS*COINC. FACTOR)^2*1986 POLES/1973 POLES*2/3*14.44 MFT*.1035 OHMS PER MFT+19.724MFT * .1644 OHM PER I

=(9) ^ 2 * 15837 / 14464 *2 /3 *4.737165   * 54.3873

=   0.0152 MW
==========

I. LOAD DATA

TEST YEAR PEAK LOAD (MW)	72.70
TEST YEAR MWH GENERATED AND PURCHASED	418,366
TEST YEAR MWH ACCOUNTED FOR	394,003
TEST YEAR UNACCOUNTED FOR MWH LOSSES	24,363
TEST YEAR LOAD FACTOR: ((GEN & PUR)/8760/PEAK LOAD)	65.69%
TEST YEAR AVERAGE PEAK (MW): ((GEN & PUR)/8760 HRS PER YR)	47.76
TEST YEAR OFF PEAK LOAD (MW)	48.25
TEST YEAR OFF PEAK PERIOD LOAD FACTOR W/OFF PK LOAD	.81.30%
TEST YEAR ON PEAK PERIOD LOAD FACTOR	81.37%
TEST YEAR OFF PEAK LOAD FACTOR WITH ON PEAK PK	53.96%

II. LOAD FLOW DATA

TRANSMISSION SYSTEM LINE LOSS	67.68 MW PEAK	0.2565 MW
SUBTRANSMISSION SYSTEM LINE LOSS	67.68 MW PEAK	0.0869 MW
TRANSMISSION SYSTEM LINE LOSS	47.74 MW PEAK	0.1317 MW
SUBTRANSMISSION SYSTEM LINE LOSS	47.74 MW PEAK	0.0370 MW

I. DERIVATION OF COINCIDENT LOADING FACTOR

PEAK (MW)   72.700
MVA @ .95% POWER FACTOR   76.526

KNOWN COINCIDENT LOADS:

ELECTRIC STATION (AMPS * 13.8 KV * SQUARE ROOT OF 3)

# 6 TF	4.8
#8 FDR	2.64
#11 FDR	3.36
#17 FDR	0.24
#10AB	1.2
#10	3.6
SS #4	0.24
MVA	16.08

FLAGG POND #2 FDR

3.74 MW/.8 PF	4.68
TOTAL KNOWN	20.76

COINCIDENT LOAD MVA FOR
THE REST OF THE SYSTEM *

	SUBSTATIONS:	NONCOINCIDENT MVA	COINCIDENT MVA (NONCOIN*.9165)	NAMEPLATE MVA
P	CANTON 4 KV	2.544	2.629	2.500
P	CANTON 13 KV	2.736	2.828	10.000
P	ELLIS ST	2.184	2.257	2.500
P	ELEC STATION *	4.800	4.961	3.750
P	LUN 4 KV	4.080	4.217	5.000
P	NOCKEGE 4 KV *	2.995	3.095	2.500
P	PLEASANT 4 KV	0.996	1.029	10.000
P	PLEASANT 13 KV	6.144	6.350	1.500
P	RINDGE 4 KV	1.152	1.191	10.000
P	RIVER 13 KV	8.550	8.837	2.500
P	SO. FITCH 4KV *	1.411	1.458	7.500
P	TOWNSEND 13 KV	6.432	6.648	3.000
P	WALLACE 4 KV	1.930	1.995	1.500
P	W. FITCH	0.922	0.953	3.750
P	W. TOWNSEND	3.328	3.440	7.500
	#39 FDR	5.200	5.374	
	#38 FDR	2.860	2.956	
	#40 FDR	2.400	2.480	
	BEECH ST	2.500	2.584	

TOTAL NON COINCIDENT LOAD   63.164 MVA   65.281 MVA
LESS*(* INCLUDED ELSEWHERE)   53.958 MVA   55.766 MVA

TOTAL PRIMARY LOAD (P)   50.204 MVA   73.500 MVA

COINCIDENT LOADING FACTOR = COINCIDENT LOAD OF REST OF THE SYSTEM / NONCOINCIDENT LOAD
= 55.766 / 53.958 = 1.0335

KVA	QTY	SUBTOTAL
1.5	28	42
2.5	1	2.5
3	16	48
5	505	2525
7.5	2	15
9	14	126
10	1216	12160
15	808	12120
25	1400	35000
30	51	1530
37.5	191	7162.5
45	47	2115
50	229	11450
75	81	6075
100	53	5300
112	13	1456

4655   97127 KVA   * 0.00537 KW/KVA =   521.57

COIL LOSS
10-45 KVA:

72846 /   148917 * 0.0148 KW/KVA = 0.007239 KW

150	18	2700
150	6	900
167	13	2171
200	3	600
225	4	900
250	4	1000
300	33	9900
333	3	999
500	21	10500
750	4	3000

109   32670 KVA   * 0.00317 KW/KVA =   103.56

COIL LOSS
50-500 KVA:

53951 /   148917 * 0.0103 KW/KVA = 0.003731 KW

1000	3	3000
1500	1	1500
2500	1	2500

5   7000   *   0.002 KW/KVA =   14.00

GRAND TOTAL   4769   136797 KVA

COIL LOSS
750 + KVA

CUSTOMER OWNED
SECONDARY METERED

12120 KVA   * 0.00317 KW/KVA =   38.42

22120 /   148917 * 0.00746 KW/KVA = 0.001108 KW

148917 KVA   TOTAL CORE LOSS =   677.56   COMPOSITE COIL LOSS = 0.012079 KW/

FITCHBURG LOSS STUDY
TRANSFORMER LOADING INFORMATION
& LINE LOSS INFORMATION

WESTINGHOUSE LOSS RATINGS:
CORE   0.002 MW/MVA
COIL   0.006 MW/MVA

I. SUBTRANSMISSION VOLTAGE LEVEL:	NAMEPLATE RATING MVA	RATING AT PEAK LOAD
		(INCLUDED IN LOSS STUDY)
FLAGG POND 115/13.8 KV DELTA		6.722 (SAWMILL, WALL, RINGE, W.FITCH)
BEECH ST 69/13.8 KV DELTA	12.000	10.811 (BEECH,SAWMILL,WATER)
SUMMER ST 69/13.8 KV DELTA	21.000	16.080
GENERATOR #6 ELECTRIC STATION 69/13.8 KV DELTA	18.000	
TOTAL SUBTRANSMISSION LOADING	51.000 MVA	33.613 MVA

II. PRIMARY & SECONDARY LINE LOSS CALCULATIONS

PRIMARY LINE LOSS
AVERAGE   = (AMPS ÷ % LOAD ON PEAK)*AVE LOAD FACTOR)^2)^2*MILES*CONDUCTORS*OHMS PER M FT*5.28 M FT PER MILE * HRS IN PERIOD
= (230 ÷ 0.19)^2 *   477.05   *   2 * 0.1635 *   5.28 *   8760
= (1.544 *   8760
=   1524   MWH

PRIMARY LINE LOSS
ON-PEAK   = (AMPS ÷ % LOAD ON PEAK*ON-PEAK LOAD FACTOR)^2)^2*MILES*CONDUCTORS*OHMS PER M FT*5.28 M FT PER MILE * HRS IN PERIOD
= (230 ÷ 0.27)^2 *   477.05   *   2 * 0.1635 *   5.28 *   3750
= 3.065 *   3750
=   11533 MWH

PRIMARY LINE LOSS
OFF-PEAK = (AMPS ÷ % LOAD ON PEAK*OFF-PEAK LOAD FACTOR)^2)^2*MILES*CONDUCTORS*OHMS PER M FT*5.28 M FT PER MILE * HRS IN PERIOD
= (230 ÷ 0.12)^2 *   477.05   *   2 * 0.1635 *   5.28 *   5010
= 0.597 *   5010
=   2993   MWH

SECONDARY SERVICES
AVE LOSSES = (LOAD FACTOR * AMPS)^2*OHMS PER M FT*CUSTOMERS*AMP FT*CONDUCTORS*HR IN PER
= 0.655928 *   (6)^2 *   0.4157   *   24286   * 2 * 8760
= 0.025097 *   8760
=   220   MWH

SECONDARY SERVICES
ON-PEAK LOSSES = (LOAD FACTOR * AMPS)^2*OHMS PER M FT*CUSTOMERS*AMP FT*CONDUCTORS*HR IN PER
= 0.813352 *   (6)^2 *   0.4157   *   24286   * 2 * 3750
= 0.038504 *   3750
=   144   MWH

SECONDARY SERVICES
OFF-PEAK LOSSES = (LOAD FACTOR * AMPS)^2*OHMS PER M FT*CUSTOMERS*AMP FT*CONDUCTORS*HR IN PER
= 0.535599 *   (6)^2 *   0.4157   *   24286   * 2 * 5010
= 0.016932 *   5010
=   85   MWH

SECONDARY MAINS
AVE LOSSES = ASSUME 2 SPANS, 2 CUSTOMERS EACH WITH 75% COINCIDENCE FACTOR
(24AMPS*COINC. FACTOR*LOAD FACTOR)^2*195% POLES/1973 POLES*2/3*14.44 M FT*.1035 OHMS PER M FT*19.72M FT * .1644 OHM PER M FT * SCALE FACTOR * HR IN PER
= (9 *0.655928)^2 * 15837 / 11464 *2 /3 * (4.737165 * 54.3873 *   8760
= 0.005574 *   8760
=   58   MWH

SECONDARY MAINS
ON-PEAK LOSSES = ASSUME 2 SPANS, 2 CUSTOMERS EACH WITH 75% C.F.
(24AMPS*COINC. FACTOR*LOAD FACTOR)^2*195% POLES/1973 POLES*2/3*14.44 M FT*.1035 OHMS PER M FT*19.72M FT * .1644 OHM PER M FT * SCALE FACTOR * HR IN PER
= (9 *0.813352)^2 * 15837 / 11464 *2 /3 * (4.737165 * 54.3873 *   3750
= 0.010085 *   3750
=   38   MWH

SECONDARY MAINS
OFF-PEAK LOSSES = ASSUME 2 SPANS, 2 CUSTOMERS EACH WITH 75% C.F.
(24AMPS*COINC. FACTOR*LOAD FACTOR)^2*195% POLES/1973 POLES*2/3*14.44 M FT*.1035 OHMS PER M FT*19.72M FT * .1644 OHM PER M FT * SCALE FACTOR * HR IN PER
= (9 *0.535599)^2 * 15837 / 11464 *2 /3 * (4.737165 * 54.3873 *   5010
= 0.004435 *   5010
=   22   MWH

PRIMARY LOSS FACTOR
AVE   = PRIMARY LINE LOSSES / TOTAL PRIMARY AND SECONDARY LOSSES
= 1524 / 13802 = 0.5799

ADJUSTED ON-PEAK PRIMARY LOSS = AVE ADJ PRIMARY LINE LOSSES FROM SCH 2A / AVE PRIMARY LINE LOSSES * ON-PEAK PRIM LINE LOSSES
= 12459 / 11524 * 11533 =   10658

ADJUSTED OFF-PEAK PRIMARY LOSS = AVE ADJ PRIMARY LINE LOSSES FROM SCH 2A / AVE PRIMARY LINE LOSSES * OFF-PEAK PRIM LINE LOSSES
= 12459 / 11524 * 2993 =   2754

SECONDARY LOSS FACTOR = SECONDARY SERVICES AND MAINS LOSSES / TOTAL PRIMARY AND SECONDARY LOSSES
AVE   = 277 / 13802 = 0.0201

ADJUSTED ON-PEAK SECONDARY LOSS = AVE ADJ SECONDARY LOSSES FROM SCH 2A / AVE SECONDARY LINE LOSSES * ON-PEAK SECONDARY LOSSES
= 256 / 277 * 182 =   168

ADJUSTED OFF-PEAK SECONDARY LOSS = AVE ADJ SECONDARY LOSSES FROM SCH 2A / AVE SECONDARY LINE LOSSES * OFF-PEAK SECONDARY LOSSES
=

Marginal Loss Study

FITCHBURG MARGINAL LOSS STUDY SCHEDULE 1A
SUMMARY OF MWH LOSSES

I. AVERAGE LOAD LEVEL (49.08 MW)

	LINE	CORE	COIL	TOTAL MWH	CUM MARGINAL MWH	CUM AVERAGE MWH	MARGINAL % DIFFERENCE
TRANSMISSION	1,219	—	—	1,219	1,219	1,155	0.736
SUBTRANSMISSION	343	894	527	1,763	2,982	2,875	1.224
PRIMARY	12,917	1,288	824	15,028	18,010	17,399	6.981
SECONDARY	274	5,935	818	7,027	25,038	24,363	7.704

II. ON PEAK LOAD LEVEL (73.7 MW)

	LINE	CORE	COIL	TOTAL MWH	CUM MARGINAL MWH	CUM AVERAGE MWH	MARGINAL % DIFFERENCE
TRANSMISSION	677	—	—	677	677	612	1.741
SUBTRANSMISSION	190	383	329	902	1,579	1,476	2.745
PRIMARY	10,048	551	514	11,114	12,693	12,210	12.870
SECONDARY	171	2,541	511	3,223	15,915	15,382	14.225

III. OFF PEAK LOAD LEVEL (48.25 MW)

	LINE	CORE	COIL	TOTAL MWH	CUM MARGINAL MWH	CUM AVERAGE MWH	MARGINAL % DIFFERENCE
TRANSMISSION	542	—	—	542	542	542	0.003
SUBTRANSMISSION	152	511	198	861	1,403	1,399	0.085
PRIMARY	2,869	736	309	3,915	5,318	5,130	2.552
SECONDARY	103	3,395	307	3,805	9,122	8,981	2.822

I. AT PEAK LOAD LEVEL (73.7 MW)

	LINE	CORE	COIL	TOTAL MW	CUM MARGINAL MW	CUM AVERAGE MW	MARGINAL % DIFFERENCE
TRANSMISSION	0.3042	---	---	0.3042	0.3042	0.296	0.816
SUBTRANSMISSION	0.1030	0.1020	0.1355	0.3406	0.6448	0.6311	1.365
PRIMARY	7.2504	0.1470	0.2120	7.6094	8.2541	8.0217	23.244
SECONDARY	0.0734	0.6776	0.2106	0.9616	9.2157	8.9771	23.860

HOURS IN
PERIOD   8760

I. TRANSMISSION

        A. LINE LOSSES   = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
                            = (89 PEAK/ 81 OFF PEAK * ANNUAL LOAD FACTOR)^2 * OFF PEAK LINE LOSSES * HOURS PER PERIOD
                            =   1.0570 *   0.1317 *   8760
                            =   0.1392 *   8760
                            =   1219 MWH
                              ==========

        B. TRANSFORMER LOSSES
                CORE   =   NONE

                COIL   =   NONE

II. SUBTRANSMISSION

        A. LINE LOSSES   = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
                            = (89 PEAK/ 81 OFF PEAK * ANNUAL LOAD FACTOR)^2 * OFF PEAK LINE LOSSES * HOURS PER PERIOD
                            =   1.0570 *   0.037 *   8760
                            =   0.0391 *   8760
                            =   343 MWH
                              ==========

        B. TRANSFORMER LOSSES

                CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B) * HRS IN PERIOD
                            =   51.000 *   0.002 *   8760
                            =   0.1020 *   8760
                            =   894 MWH
                              ==========

                COIL   = (RATIO OF PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
                            = (33.943 /   51.000 *0.665964) ^2 *   51.000 *   0.006 *   8760
                            =   0.0601 *   8760
                            =   527 MWH
                              ==========

III. PRIMARY
        B. TRANSFORMER LOSSES

                CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B) * HRS IN PERIOD
                            =   73.500 *   0.002 *   8760
                            =   0.1470 *   8760
                            =   1288 MWH
                              ==========

                COIL   = (RATIO OF PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
                            = (50.957 /   73.500 *0.665964) ^2 *   73.500 *   0.006 *   8760
                            =   0.0940 *   8760
                            =   824 MWH
                              ==========

IV. SECONDARY

        B. TRANSFORMER LOSSES

                CORE   = CORE LOSS IN MW FROM WORKPAPER 2B * HOURS IN PERIOD
                            =   0.6776 *   8760
                            =   5935 MWH
                              ==========

                COIL   = (RATIO OF PRIMARY PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
                            = (50.957 / 148.917 *0.665964) ^2 *   148.917 *0.012079 *   8760
                            =   0.0934 *   8760
                            =   818 MWH
                              ==========

V. DERIVATION OF PRIMARY AND SECONDARY LINE LOSSES

            TOTAL ANNUAL LOSSES=   25038 MWH
            TOTAL IDENTIFIED   =   11847 MWH

            REMAINING LOSSES   =   13191 MWH

        PRIMARY LINE LOSSES   = PRIMARY LOSS FACTOR FROM WORKPAPER 2C * REMAINING LOSSES
                              =   0.9793 *   13191
                              =   12917 MWH
                                ==========

        SECONDARY LINE LOSSES = SECONDARY LOSS FACTOR FROM WORKPAPER 2C * REMAINING LOSSES
                              =   0.0207 *   13191
                              =   274 MWH
                                ==========

HOURS IN
PERIOD   3750

I. TRANSMISSION

A. LINE LOSSES = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
= (89 PEAK/ 81 PEAK * ON PEAK LOAD FACTOR)^2 * ON PEAK LINE LOSSES * HOURS PER PERIOD
= 0.7851 *   0.2565 *   3750
= 0.2014 *   3750
= 755 MWH
========

B. TRANSFORMER LOSSES

CORE   =   NONE

COIL   =   NONE

II. SUBTRANSMISSION

A. LINE LOSSES = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
= (89 PEAK/ 81 ON PEAK * ON PEAK LOAD FACTOR)^2 * ON PEAK LINE LOSSES * HOURS PER PERIOD
= 0.7851 *   0.0869 *   3750
= 0.0682 *   3750
= 256 MWH
========

B. TRANSFORMER LOSSES

CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B) * HRS IN PERIOD
= 51.000 *   0.002 *   3750
= 0.1020 *   3750
= 383 MWH
========

COIL   = (RATIO OF PK TO NAMEPLATE*ON PK LOAD FCTR)^2 * NMPLATE RATE * WEST LOSS FCTR * HRS IN PERIOD
= (33.943 /   51.000 *0.813692) ^2 *   51.000 *   0.006 *   3750
= 0.0897 *   3750
= 337 MWH
========

III. PRIMARY

B. TRANSFORMER LOSSES

CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B) * HRS IN PERIOD
= 73.500 *   0.002 *   3750
= 0.1470 *   3750
= 551 MWH
========

COIL   = (RATIO OF PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
= (50.957 /   73.500 *0.813692) ^2 *   73.500 *   0.006 *   3750
= 0.1403 *   3750
= 526 MWH
========

IV. SECONDARY

B. TRANSFORMER LOSSES

CORE   = CORE LOSS IN MW FROM WORKPAPER 2B * HOURS IN PERIOD
= 0.6776 *   3750
= 2541 MWH
========

COIL   = (RATIO OF PRIMARY PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
= (50.957 / 148.917 *0.813692) ^2 *   148.917 *0.012079 *   3750
= 0.1395 *   3750
= 523 MWH
========

V. DERIVATION OF PRIMARY AND SECONDARY LINE LOSSES

PRIMARY LINE LOSSES   = ADJUSTED PRIMARY ON-PEAK LOSS FROM WORKPAPER 2C
ON-PEAK   = 11105 MWH
========

SECONDARY LINE LOSSES = ADJUSTED SECONDARY ON-PEAK LOSS FROM WORKPAPER 2C
ON-PEAK   = 175 MWH
========

HOURS IN
PERIOD   5010

I. TRANSMISSION

A. LINE LOSSES   = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
                = (89 OFF-PEAK PEAK/ 81 OFF-PEAK PEAK * OFF PEAK LOAD FACTOR)^2 * OFF PEAK LINE LOSSES * HOURS PER PERI
                =   0.8217 *   0.1317 *   5010
                =   0.1082 *   5010
                =   542 MWH

B. TRANSFORMER LOSSES
    CORE   =   NONE

    COIL   =   NONE

II. SUBTRANSMISSION

A. LINE LOSSES   = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
                = (89 OFF-PEAK PEAK/ 81 OFF-PEAK PEAK * OFF PEAK LOAD FACTOR)^2 * OFF PEAK LINE LOSSES * HOURS PER PERI
                =   0.8217 *   0.037 *   5010
                =   0.0304 *   5010
                =   152 MWH

B. TRANSFORMER LOSSES

    CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B) * HRS IN PERIOD
             =   51.000 *   0.002 *   5010
             =   0.1020 *   5010
             =   511 MWH

    COIL   = (RATIO OF PK TO NAMEPLATE*OFF PK LOAD FCTR)^2 * NMPLATE RATE * WEST LOSS FCTR * HRS IN PERIOD
             = (33.943 /   51.000 * 0.5396) ^2 *   51.000 *   0.006 *   5010
             =   0.0395 *   5010
             =   198 MWH

III. PRIMARY

B. TRANSFORMER LOSSES

    CORE   = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B) * HRS IN PERIOD
             =   73.500 *   0.002 *   5010
             =   0.1470 *   5010
             =   736 MWH

    COIL   = (RATIO OF PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
             = (50.957 / 73.500 * 0.5396) ^2 *   73.500 *   0.006 *   5010
             =   0.0617 *   5010
             =   309 MWH

IV. SECONDARY

B. TRANSFORMER LOSSES

    CORE   = CORE LOSS IN MW FROM WORKPAPER 2B * HOURS IN PERIOD
             =   0.6776 *   5010
             =   3395 MWH

    COIL   = (RATIO OF PRIMARY PEAK TO NAMEPLATE*LOAD FACTOR)^2 * NAMEPLATE RATING * LOSS FACTOR * HRS IN PERIOD
             = (50.957 / 148.917 * 0.5396) ^2 *   148.917 *0.012079 *   5010
             =   0.0613 *   5010
             =   307 MWH

V. DERIVATION OF PRIMARY AND SECONDARY LINE LOSSES

PRIMARY LINE LOSSES   = ADJUSTED PRIMARY OFF-PEAK LOSS FROM WORKPAPER 2C
  OFF-PEAK   =   2869 MWH

SECONDARY LINE LOSSES = ADJUSTED SECONDARY OFF-PEAK LOSS FROM WORKPAPER 2C
  OFF-PEAK   =   103 MWH

I. TRANSMISSION

A. LINE LOSSES = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
= (89 PEAK/ 81 PEAK)^2 * ON PEAK LINE LOSSES
= 1.1858 * 0.2565
= 0.3042 MW
==========

B. TRANSFORMER LOSSES

CORE = NONE

COIL = NONE

II. SUBTRANSMISSION

A. LINE LOSSES = PROFORMED LINE LOSSES FROM LOADFLOW * HOURS PER PERIOD
= (89 PEAK/ 81 PEAK)^2 * ON PEAK LINE LOSSES
= 1.1858 * 0.0869
= 0.1030 MW
==========

B. TRANSFORMER LOSSES

CORE = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B)
= 51.000 * 0.002
= 0.1020 MW
==========

COIL = (RATIO OF PK TO NAMEPLATE)^2 * NMPLATE RATE * WEST LOSS FCTR
= (33.943 / 51.000) ^2 * 51.000 * 0.006
= 0.1355 MW
==========

III. PRIMARY

B. TRANSFORMER LOSSES

CORE = NAMEPLATE RATING * WESTINGHOUSE LOSS FACTOR(WP-2B)
= 73.500 * 0.002
= 0.1470 MW
==========

COIL = (RATIO OF PEAK TO NAMEPLATE)^2 * NAMEPLATE RATING * LOSS FACTOR
= (50.957 / 73.500) ^2 * 73.500 * 0.006
= 0.2120 MW
==========

IV. SECONDARY

B. TRANSFORMER LOSSES

CORE = CORE LOSS IN MW FROM WORKPAPER 2B * HOURS IN PERIOD
= 0.6776 MW
==========

COIL = (RATIO OF PRIMARY PEAK TO NAMEPLATE)^2 * NAMEPLATE RATING * LOSS FACTOR
= (50.957 / 148.917) ^2 * 148.917 * 0.012079
= 0.2106 MW
==========

V. DERIVATION OF PRIMARY AND SECONDARY LINE LOSSES

PRIMARY LINE LOSS = (AMPS * % LOAD ON PEAK)^2*MILES*CONDUCTORS*OHMS PER M FT*5.28 MFT PER MILE
ON-PEAK =(230 * 0.41)^2 * 477.05 * 2 * 0.1635 * 5.28
= 7.250 MW
==========

SECONDARY SERVICES = (AMPS)^2*OHMS PER MFT*CUSTOMERS*DROP FT*CONDUCTORS
ON-PEAK LOSSES =(6) ^ 2 * 0.4157 * 80 * 24288 * 2
= 0.0582 MW
==========

SECONDARY MAINS   ASSUME 2 SPANS, 2 CUSTOMERS EACH WITH 75% COINCIDENCE FAC
ON-PEAK LOSSES = (2*AMPS*COINC. FACTOR)^2*1986 POLES/1973 POLES*2/3*14.44 MFT*.1035 OHMS PER MFT+19.724MFT * .1644 OHM PER
=(9) ^ 2 * 15837 / 14464 *2 /3 *4.737165 * 54.3873
= 0.0152 MW

FITCHBURG LOSS STUDY
LOAD AND LOAD FLOW DATA
MARGINAL LOSSES

WORKPAPER 1

I. LOAD DATA

TEST YEAR PEAK LOAD (MW)	73.70
TEST YEAR MWH GENERATED AND PURCHASED	429,955
TEST YEAR MWH ACCOUNTED FOR	404,917
TEST YEAR UNACCOUNTED FOR MWH LOSSES	25,038
TEST YEAR LOAD FACTOR: ((GEN & PUR)/8760/PEAK L	66.60%
TEST YEAR AVERAGE PEAK (MW): ((GEN & PUR)/8760	49.08
TEST YEAR OFF PEAK LOAD (MW)	48.25
TEST YEAR OFF PEAK PERIOD LOAD FACTOR	81.30%
TEST YEAR ON PEAK PERIOD LOAD FACTOR	81.37%
TEST YEAR OFF PEAK LOAD FACTOR WITH ON PEAK PK	53.96%

II. LOAD FLOW DATA

TRANSMISSION SYSTEM LINE LOSS	67.68 MW PEAK	0.2565 MW
SUBTRANSMISSION SYSTEM LINE LOSS	67.68 MW PEAK	0.0869 MW
TRANSMISSION SYSTEM LINE LOSS	47.74 MW PEAK	0.1317 MW
SUBTRANSMISSION SYSTEM LINE LOSS	47.74 MW PEAK	0.0370 MW

I. DERIVATION OF COINCIDENT LOADING FACTOR

PEAK (MW)   73.700
MVA @ .95% POWER FACTOR   77.579

KNOWN COINCIDENT LOADS:

ELECTRIC STATION (AMPS * 13.8 KV * SQUARE ROOT OF 3)

# 6 TF	4.8
#8 FDR	2.64
#11 FDR	3.36
#17 FDR	0.24
#10AB	1.2
#10	3.6
SS #4	0.24
MVA	16.08

FLAGG POND #2 FDR

3.74 MW/.8 PF   4.68

TOTAL KNOWN   20.76

COINCIDENT LOAD MVA FOR
THE REST OF THE SYSTEM *

	SUBSTATIONS:	NONCOINCIDENT MVA	COINCIDENT MVA (NONCOIN*.9165)	NAMEPLATE MVA
P	CANTON 4 KV	2.544	2.679	2.500
P	CANTON 13 KV	2.736	2.881	10.000
P	ELLIS ST	2.184	2.300	2.500
P	ELEC STATION *	4.800	5.055	3.750
P	LUN 4 KV	4.080	4.296	5.000
P	NOCKEGE 4 KV *	2.995	3.154	2.500
P	PLEASANT 4 KV	0.996	1.049	10.000
P	PLEASANT 13 KV	6.144	6.470	1.500
P	RINDGE 4 KV	1.152	1.213	10.000
P	RIVER 13 KV	8.550	9.003	2.500
P	SO. FITCH 4KV *	1.411	1.486	7.500
P	TOWNSEND 13 KV	6.432	6.773	3.000
P	WALLACE 4 KV	1.930	2.032	1.500
P	W. FITCH	0.922	0.971	3.750
P	W. TOWNSEND	3.328	3.504	7.500
	#39 FDR	5.200	5.476	
	#38 FDR	2.860	3.012	
	#40 FDR	2.400	2.527	
	BEECH ST	2.500	2.633	

TOTAL NON COINCIDENT LOAD   63.164 MVA   66.513 MVA
LESS*(* INCLUDED ELSEWHERE)   53.958 MVA   56.819 MVA

TOTAL PRIMARY LOAD (P)   50.957 MVA   73.500 MVA

COINCIDENT LOADING FACTOR = COINCIDENT LOAD OF REST OF THE SYSTEM / NONCOINCIDENT LOAD
                          = 56.819 / 53.958 = 1.0530

KVA	QTY	SUBTOTAL
1.5	28	42
2.5	1	2.5
3	16	48
5	505	2525
7.5	2	15
9	14	126
10	1216	12160
15	808	12120
25	1400	35000
30	51	1530
37.5	191	7162.5
45	47	2115
50	229	11450
75	81	6075
100	53	5300
112	13	1456

COIL LOSS
10-45 KVA:

72846 /   148917 * 0.0148 KW/KVA = 0.007239 KW/KVA

4655   97127 KVA   * 0.00537 KW/KVA =   521.57

150	18	2700
150	6	900
167	13	2171
200	3	600
225	4	900
250	4	1000
300	33	9900
333	3	999
500	21	10500
750	4	3000

COIL LOSS
50-500 KVA:

53951 /   148917 * 0.0103 KW/KVA = 0.003731 KW/KVA

109   32670 KVA   * 0.00317 KW/KVA =   103.56

1000	3	3000
1500	1	1500
2500	1	2500

5   7000   * 0.002 KW/KVA =   14.00

COIL LOSS
750 + KVA

GRAND TOTAL 4769   136797 KVA

CUSTOMER OWNED
SECONDARY METERED   12120 KVA   * 0.00317 KW/KVA =   38.42

22120 /   148917 * 0.00746 KW/KVA = 0.001108 KW/KVA

148917 KVA   TOTAL CORE LOSS =   677.56

COMPOSITE COIL LOSS   = 0.012079 KW/KVA

FITCHBURG LOSS STUDY
TRANSFORMER LOADING INFORMATION
& LINE LOSS INFORMATION

WESTINGHOUSE LOSS RATINGS:
CORE   0.002 MW/MVA
COIL   0.006 MW/MVA

I. SUBTRANSMISSION VOLTAGE LEVEL:

	NAMEPLATE RATING MVA	RATING AT PEAK LOAD
FLAGG POND 115/13.8 KV DELTA		
BEECH ST 69/13.8 KV DELTA	12.000	6.849
SUMEN ST 69/13.8 KV DELTA	21.000	11.015
GENERATOR #6 ELECTRIC STATION 69/13.0 KV DELTA	18.000	16.000

(INCLUDED IN LOSS STUDY)
CARMILL, HILL, RIDGE, N. FITCHO
(430,435,440 FEED)

TOTAL SUBTRANSMISSION LOADING   51.000 MVA   33.943 MVA

II. PRIMARY & SECONDARY LINE LOSS CALCULATIONS

(2)

PRIMARY LINE LOSS = (AMPS # $ LOAD ON PERKAME LOAD FACTOR)^2 * 2*MILE#CONDUCTOR#OHMS PER N FT*5.28 MFT PER MILE * HRS IN PERIOD
AVERAGE   =(230 * 0.19)^2 * 2 * 477.05 * 0.1635 * 5.28 * 8760
                   = 1.535 MWH
                     13458   8760

PRIMARY LINE LOSS = (AMPS # $ LOAD ON PEAK*ON-PEAK LOAD FACTOR)^2 * 2*MILE#CONDUCTOR#OHMS PER N FT*5.28 MFT PER MILE * HRS IN PERIOD
ON-PEAK   =(230 * 0.27)^2 * 2 * 477.05 * 0.1635 * 5.28 * 3750
                   = 3.065 MWH
                     11563   3750

PRIMARY LINE LOSS = (AMPS # $ LOAD ON PEAK*OFF-PEAK LOAD FACTOR)^2 * 2*MILE#CONDUCTOR#OHMS PER N FT*5.28 MFT PER MILE * HRS IN PERIOD
OFF-PEAK   =(230 * 0.12)^2 * 2 * 477.05 * 0.1635 * 5.28 * 5010
                   = 0.597 MWH
                     2399   5010

SECONDARY SERVICES = (LOAD FACTOR * AMPS)^2*OHMS PER N FT*CUSTOMERS*AMP FT*CONDUCTOR*HR IN PER
AVE LOSSES   =(0.645964 * 6)^2 * 0.4157 * 80 * 2 * 24398 * 8760
                   = 0.02792 *
                   = 225 MWH

SECONDARY SERVICES = (LOAD FACTOR * AMPS)^2*OHMS PER N FT*CUSTOMERS*AMP FT*CONDUCTOR*HR IN PER
ON-PEAK LOSSES   =(0.81352 * 6)^2 * 0.4157 * 80 * 2 * 24398 * 3750
                   = 0.03504 *
                   = 144 MWH

SECONDARY SERVICES = (LOAD FACTOR * AMPS)^2*OHMS PER N FT*CUSTOMERS*AMP FT*CONDUCTOR*HR IN PER
OFF-PEAK LOSSES   =(0.53549 * 6)^2 * 0.4157 * 80 * 2 * 24398 * 5010
                   = 0.01832 *
                   = 65 MWH

SECONDARY MAINS   ASSUME 2 SPANS, 2 CUSTOMERS EACH WITH 75% COINCIDENCE FACTOR
AVE LOSSES   (2*AMPS*COINC. FACTOR*LOAD FACTOR)^2 * 2 * 15437 / 14464 * 2 /3 * 4.737165 * 54.3873
                   =(9 *0.645964)^2 * 2 * 15437 / 14464 * 2 /3 * 4.737165 * 54.3873 *
                   = 0.06756 *
                   = 59 MWH

SECONDARY MAINS   ASSUME 2 SPANS, 2 CUSTOMERS EACH WITH 75% C.F.
ON-PEAK LOSSES   (2*AMPS*COINC. FACTOR*LOAD FACTOR)^2*MILES POLES=2/3*4.44 MFT*.1035 OHMS PER MFT*19.72*MFT * .1644 OHM PER MFT * SCALE FACTOR * HR IN PER
                   =(9 *0.81352)^2 * 2 * 15437 / 14464 *2 /3 *4.737165 * 54.3873 *   3750
                   = 0.01065 *
                   = 38 MWH

SECONDARY MAINS   ASSUME 2 SPANS, 2 CUSTOMERS EACH WITH 75% C.F.
OFF-PEAK LOSSES   (2*AMPS*COINC. FACTOR*LOAD FACTOR)^2*MILES POLES=2/3*4.44 MFT*.1035 OHMS PER MFT*19.72*MFT * .1644 OHM PER MFT * SCALE FACTOR * HR IN PER
                   =(9 *0.53549)^2 * 2 * 15437 / 14464 *2 /3 *4.737165 * 54.3873 *   5010
                   = 0.00415 *
                   = 22 MWH

PRIMARY LOSS FACTOR = PRIMARY LINE LOSSES / TOTAL PRIMARY AND SECONDARY LOSSES
   AVE   13458 / 13743 = 0.5753

ADJUSTED ON-PEAK PRIMARY LOSS = AVE ADJ PRIMARY LINE LOSSES FROM SCH 2A / AVE PRIMARY LINE LOSSES * ON-PEAK PRIM LINE LOSSES
                                 12917 / 13458 * 11569 =   11105

ADJUSTED OFF-PEAK PRIMARY LOSS = AVE ADJ PRIMARY LINE LOSSES FROM SCH 2A / AVE PRIMARY LINE LOSSES * OFF-PEAK PRIM LINE LOSSES
                                 12917 / 13458 * 2949 =   2849

SECONDARY LOSS FACTOR = SECONDARY SERVICES AND MAINS LOSSES / TOTAL PRIMARY AND SECONDARY LOSSES
   AVE   285 / 13743 = 0.0207

ADJUSTED ON-PEAK SECONDARY LOSS = AVE ADJ SECONDARY LOSSES FROM SCH 2A / AVE SECONDARY LINE LOSSES * ON-PEAK SECONDARY LOSSES
                                  274 / 285 * 182 =   175

ADJUSTED OFF-PEAK SECONDARY LOSS = AVE ADJ SECONDARY LOSSES FROM SCH 2A / AVE SECONDARY LINE LOSSES * OFF-PEAK SECONDARY LOSSES